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Optimised Hyperchaotic Modes of a Triple Pendulum

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<p>Analytical equations of motion, in the form d<i>x_i</i>/d<i>t</i> = <i>f_i</i>(<i>x</i>,<i>t</i>), are derived for a damped harmonically driven triple plane pendulum. This form of the equations clearly displays the nature of the non-linear coupling and provides a basis for physical interpretation. The equations also facilitate the derivation of the Jacobian matrix in analytical form, a result which is important for the accurate numerical computation of the Lyapunov exponents. It is shown that sets of optimised parameters, such as the lengths and masses of the pendulum, may be derived by using the Nelder-Mead simplex optimisation algorithm. This method gives precise control over the Lyapunov exponents and may be useful in a wide variety of other non-linear applications, such as those occurring in biophysics and information technology (for secure communication). As an example of the technique it is used to predict periodic and quasi-periodic orbits of the un-damped pendulum, as well as its chaotic and hyperchaotic modes. The maximum positive Lyapunov exponents for the pendulum are found to vary from zero, for periodic orbits, to as high as ten for the optimised hyperchaotic modes. Numerical simulations, coded in Python, are used to visualise the results.
</p>

Level (Hons, MSc,
   PhD, other)?

other

Consider for a student
   award (Yes / No)?

No

Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?

Yes

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